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Agricultural Supply Response and Poverty in Mozambique

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Summary. – This paper identifies key causal factors behind farmers' marketing decisions in Mozambique. A two-step decision making process is outlined. Farmers decide, first, whether or not to participate in the market. Next, they decide how much to sell. The model is estimated using a Heckman switching regression approach. The key importance of non-price factors such as risk, technology and transport infrastructure come out clearly. Marginal effects are calculated for poor and nonpoor households and broken down into a market participation and a quantity (sales value) component. The marginal effects for the poor are not substantially different from those of the nonpoor. This suggests that differences in area-based characteristics (especially risk and technology) are more influential in the commercialization process than differences in how the poor and the nonpoor respond to incentives. Moreover, interventions to promote market access are likely to solicit a greater volume of additional supply from peasants entering the market for the first time than from existing market participants stepping up their production and sales. To achieve pro-poor rural growth it is essential to address explicitly the conditions of high-risk, low productivity and low capital endowments of poor farmers.

Keywords: agriculture, commercialization, supply response, food marketing, Africa, Mozambique.
JEL-Codes: Q12, Q18, O13

1. Introduction

Subsistence agriculture entails large inefficiencies in resource allocation that poor countries can ill afford. Subsistence farmers are among the poorest and most vulnerable of all groups. Integrating traditional smallholder peasants into the exchange economy is therefore important for stimulating growth, economic development, food security and poverty alleviation. The need for increased agricultural commercialization is nowhere as evident as in Sub-Saharan Africa (SSA). Large numbers of African peasants remain outside the cash economy,[1] and risks and transaction costs far exceed those of any other region of the world (Delgado, 1995).

The supply response of African farmers and the merits of ‘pricism versus structuralism’ were hotly debated during the 1980s and early 1990s in the literature on structural adjustment in SSA.[2] It has for some time been clear that Africa needs to move beyond adjustment to development (Cornia and Helleiner, 1994), and agricultural commercialization has to play a crucial part in this process if it is to result in poverty alleviation and improved food security. Yet, much remains to be learned - both conceptually and empirically - about the commercialization process, including its determinants and the role played by transaction costs and risk (Mamingi, 1997).

One of the major contributions in this area of research is a volume of case studies edited by von Braun and Kennedy (1994). The links among commercialization, nutrition, poverty and gender are clearly illuminated, and attention is paid to how risk influences the proportion of land, farmers allocate to cash crops. Nevertheless, the impact of exogenous explanatory variables on marketing decisions is not modelled empirically. Modelling the decision to enter the output market is potentially important in situations where many households rely on subsistence farming.

Transaction costs, risk and other factors create barriers or thresholds for households to participate in crop markets, and understanding in more depth the decisions involved is important for policy.

In this paper we model marketing behaviour as a two-step decision process: (i) the household decides whether or not to participate in the market, and (ii) establishes how much to sell. The model is estimated using a Heckman or switching regression approach, inspired by the work of Goetz (1992). This approach is adopted in an attempt to address peasant self-selection into sellers and non-sellers. More specifically, we estimate reduced form equations both for market participation and quantities sold. The advantage of this approach is that it allows us to distinguish between the factors that determine whether or not to sell any output on the market at all, and the factors that influence how much peasants sell, given they produce for the market. For policy analysis, it is of interest to focus attention on policies to promote the commercialization process (Sadoulet and de Janvry, 1995), and an additional attractive feature of the approach in this paper is that it allows a detailed break down of marginal effects in the regression. Moreover, there is good reason to try to separate the two kinds of decisions involved. Many key decisions are taken at planting time, rather than at harvesting. For example, if a farmer plants cotton, he/she will market it, whereas the opposite is generally true for cassava as discussed in Section 2. A drawback is that since we are using cross-sectional data, there is relatively little price variation in the data. We are unable to deal with price lags and expectations that have received a great deal of attention in the supply response literature (as surveyed for example by Binswanger, 1990 and Sadoulet and de Janvry, 1995). Thus, we have little to say about the role of prices.

Another disadvantage of our approach is that for the selection equation to be convincingly identified, it is required that at least one regressor, which does not belong in the quantity equation, appears in the selection equation. Deaton (1997, p. 105) states that "identification requires that the variables unique to the switching equation be continuous. In many practical applications, these conditions will not be met, or at best be controversial." This study is no exception. We seek to establish identification from fixed transaction costs, but face the difficulty that the proxies for fixed transaction costs available in our data are not ideal, and we return to this issue later.

The empirical analysis relies on a 1996-97 household data set for Mozambique. This nationally representative *Inquérito Nacional aos Agregados Familiares sobre as Condições de Vida* (IAF) is a general-purpose living standard survey that covers 8,289 households selected by stratified random sampling (Ministry of Planning and Finance, Eduardo Mondlane University, and IFPRI, 1998). Mozambique, one of the poorest countries in the world, is at a relatively early stage of the commercialization and development process. The population density is only around 20 per sq. km, and social and physical infrastructure is totally inadequate as a consequence of colonial heritage, war and policy failure (Arndt, Jensen, and Tarp, 2000). Market segmentation is widespread, and the large peasant population is poorly integrated into food markets. Agricultural production systems are characterized by traditional labour-intensive and low-productive farming methods, and problems of poverty, food insecurity and aid dependence are widespread, even by African standards. Sustained output growth is required, and the only sustainable way the many poor smallholders can share in the growth process is through increased participation in output markets.

In the above context it is no easy task to set priorities for the use of scarce capital and human resources. This helps motivate this paper from which it emerges that interventions that increase market access will solicit a greater volume of additional supply from farmers entering the market for the first time than from existing market participants stepping up their sales. The marginal effects of the poor appear slightly, but not substantially lower than those of the nonpoor. This suggests that area-based differences in risk and technology can, to a large degree, account for the observed lower marketing activity of the poor. The key policy implication is to focus on targeted efforts to build up farm capital, improve market access and diffuse new crop technologies, while also paying attention to smallholder investment incentives.

2. Conceptual framework

In this section we briefly identify the theoretical model that guides our empirical analysis, and a reduced form for traded quantities, conditional on market participation, is derived. We discuss the impact of transaction costs and risk on market participation and suggest a reduced form relationship explaining the selection of marketing regime.

2.1 Analytical framework

Consider the following analytical framework adopted from Strauss (1984) and later relied on by Goetz (1992):

$$\begin{aligned} x_i^s &= x^s(p,\ z_i^s) \\ x_i^c &= x^c(p,\ [\alpha_i + \pi(p,\ z_i^s)],\ \ z_i^c) \end{aligned} \tag{1}$$

where x_i^s is production of food by household i, x_i^c consumption of food, p are goods prices, z_i^s fixed factors pertaining to production, i.e. characteristics of the household and its area, z_i^c household characteristics related to consumption, α_i exogenous income sources and $\pi(\cdot)$ farm profits, not accounting for the cost of family labour inputs. Marketed surplus is the difference between production and consumption, or

$$s_i = x_i^s - x_i^c = x^s(\cdot) - x^c(\cdot) = f(p, \alpha_i, z_i^s, z_i^c) \equiv f(X_i). \tag{2}$$

Thus, marketed quantities depend on all the exogenous variables irrespective of whether they pertain to the household's production or consumption decision. The usual restrictions imposed by theory on standard supply and demand functions do not apply to marketed surplus.

In particular, it is not necessary to estimate the complete system of demand and supply of all products (Sadoulet and de Janvry, 1995).

Denoting the absolute value of the marketed surplus |s|, Goetz (1992) shows that the elasticity of marketed surplus with respect to its price is

$$\frac{p}{|s|}\frac{\partial s}{\partial p} \quad = \quad \frac{x^s}{|s|}\frac{p}{x^s}\frac{\partial x^s}{\partial p} - \frac{x^c}{|s|}\frac{p}{x^c}\frac{\partial x^c}{\partial p} \tag{3}$$

The first term is the production elasticity weighted by the ratio of quantity produced to the absolute value of net market surplus; and the second term is the consumption elasticity weighted by the ratio of quantity consumed to net market surplus. This shows that the elasticity of market supply will be large (and positive) when there is a large production elasticity and/or a small consumption elasticity, and where a small fraction of output is initially being marketed (i.e., where there is a large degree of subsistence farming with a potential to become for-the-market). Thus, subsistence economies have considerable growth potential provided adequate outlets and incentives (broadly interpreted) for subsistence farmers to start supplying the market can be put in place.

2.2 Transaction costs and risk

There are two fundamental economic reasons underlying rural autarchy. First, subsistence farmers avoid the margin between the farm-gate selling price of food and the retail purchase price of food. This margin is often substantial. Jayne (1994) shows that food-surplus farmers in Zimbabwe are more likely to sell oilseeds, a cash crop, than are food-deficit farmers. The profitability of cash cropping is larger for net food sellers, who face a low selling price of food, than for food buyers, who face a high purchase price of food. Second, reliance on own production for subsistence is a risk management strategy in the face of price and non-price risk factors. Fluctuating food prices are a key problem, especially in the light of missing or imperfect credit and insurance markets (von Braun, Bouis, and Kennedy, 1994), and the same goes for other risks such as natural calamities.

As mentioned in the Introduction, a key econometric challenge is to correctly identify the selection equation. A possible solution was recently offered by Key, Sadoulet and de Janvry (2000). They introduce a distinction between fixed or lump sum transaction costs, on the one hand, and variable, proportional or per-unit transaction costs on the other hand. They show that both fixed and variable transaction costs impact on market participation whereas supply decisions (amount sold), conditional on market participation, only depend on variable transaction costs. This implies that fixed transaction costs can be excluded from the quantity part of the model, so they can be used econometrically to identify market participation:

$$Probability \quad (market \quad participation)_i = g(X_i, \tau_i). \tag{4}$$

Equation (4) postulates that variables which explain traded quantities also explain the selection of marketing regime, while the fixed transaction costs (denoted τ) that help determine market regime do not affect the amount traded conditional on being on the market.

Transaction costs are normally defined as all costs of entering into a contract, exchange or agreement: searching for trading partners, screening potential candidates, obtaining and verifying information, bargaining, bribing officials, transferring the product (including transport, storage and packaging cost), and monitoring, controlling and enforcing the transaction. At best, transaction costs are partly observable. No direct measurement of transaction costs is available in the data set used for this paper, as in most other data sets of this kind. Instead, we have to work with observable exogenous variables that are expected to help determine the size of transaction costs. Measures such as distance, type of transport available and information variables are examples of such exogenous transaction cost determinants. Measures of distance and transport are expected to influence variable transaction costs, whereas information variables affect fixed transaction costs.

Reliance on food self-sufficiency can also be caused by factors such as risk and seasonal cycles in prices. The fact that food prices are low around harvest time, but high in the lean season before harvest, gives peasants good reason to avoid relying overly on food markets. A crucial factor for peasant reactions to food price risk is their degree of self-sufficiency. Fafchamps (1992) investigated why big farmers devote a large share of resources to cash cropping while small farmers are predominantly oriented towards food production. It appears that risk averse farmers, whose share of food in total expenditures is large, will produce proportionally more food than farmers whose share of food in total expenditure is low. Thus, subsistence farming helps mitigate the impact of price risk. Of course, insurance comes at a cost, and in this case the cost is a reduction in expected output and sales. This is illustrated by Arndt and Tarp (2000), who put forward a CGE-model of Mozambique to analyse interactions among risk, marketing, technology and gender roles. They assume that households employ a safety-first strategy under which households plant a certain amount of cassava for risk reduction purposes only. Cassava is a drought tolerant crop that is resistant to disease and easy to store. The 'costs' associated with this strategy are estimated, and it appears among other things, that improvements in the cassava technology is a strong lever for increasing female and overall household welfare. In the empirical application, we therefore seek to control for risk by including a dummy for districts that are prone to flood or drought.

3. Estimation procedure

Using the framework of a Heckman or switching regression model (Maddala, 1983) the amount of output marketed can be estimated jointly with regime. We focus here on the value of sales of agricultural outputs as well as on the choice between autarchy and selling regime. Three models are estimated for: (i) total sales, (ii) marketing of food crops and (iii) marketing of cash crops, and each model has both a selection and a sales value component. Crop sale is not the only manner in which rural incomes and welfare may be increased. Yet, crop sales are important for incomes and productivity, especially considering the weakness of rural labour markets in many parts of Africa.

Previous studies (Goetz, 1992; Key, Sadoulet and de Janvry, 2000) used quantities sold of a single crop (eg kilogram of maize) as the dependent variable. We depart from this by using the aggregate value of sales as endogenous. This is motivated by a desire to use all available information in the data at hand, including information on those who sell other crops, than for example maize. Moreover, due to substitution among crops, some exogenous variables may increase individual crop sales at the expense of other crops. It is well-established that single crop supply is more elastic than aggregate output supply. Arguably, aggregate supply is what ultimately matters to policy (Binswanger, 1990). The choice of aggregating over multiple crops forces us to work with values because quantities cannot be aggregated directly. Values resolve this by using market prices as implicit weights. The drawback of our approach is that aggregation hides any differences in the underlying causal mechanisms related to individual crop decisions. Farmers may view different crops differently, in which case single crop estimation is necessary to provide the full picture.

Moreover, there are potential interactions between cash crops and food crops. For example, cash cropping is a strong stimulus to input intensification (through interlocked contracts), and inputs and management techniques intended for cash crops often have positive spillover effects on food crops (Poulton, Dorward and Kydd, 1998; Govereh, Jayne and Nyoro, 1999). While we recognise such effects as important, they are outside the scope of this paper.

Our statistical model can be stated as follows:

$$
\begin{aligned}
& s_i = \beta X_i + u_i \\
& s_i \text{ is observed iff } \quad \gamma X_i + \kappa\tau_i + e_i > 0 \\
& corr(u_i, e_i) = \rho \neq 0,
\end{aligned}
\tag{5}
$$

where X is a vector of all the explanatory variables except fixed transaction costs (τ), and β, γ, κ, and ρ are parameters to be estimated. Subscript i indexes households and crop aggregation (total sales, sales of basic food crops, and sales of cash crops) is suppressed for notational simplicity.

The estimation method can be explained using the example of a two-step approach, although in practice a joint likelihood function is estimated. In the first step, selection into regimes S (selling) and B (autarchy) is modelled in separate probit-type equations, i.e., an equation for selling versus autarchy including fixed and proportional transaction costs as well as all other explanatory variables. In the second step, the determinants of traded value conditional on market participation are analysed, using all explanatory variables except fixed transaction costs. Hence, both regressors and parameters are allowed to vary between the two steps. It is necessary to correct for selectivity in the second step because selling households are non-random subsets of all the sampled households. Least squares without selectivity corrections would lead to invalid estimates of the parameters for the full sample. Unconditional marginal effects (i.e., for the full sample) cannot be derived from least squares parameters and the possibility that regressors might influence market regime and traded values differently would completely escape least squares analysis. The selection regression framework applied here therefore holds promise for future empirical work on agricultural supply response and marketing. The selection framework is especially promising in situations where transaction cost barriers are important and where a large proportion of producers (or consumers for demand analysis) lives in autarchy as in the case of Mozambique.

As mentioned, the actual estimation is not performed in two steps, but as a quasi maximum likelihood procedure which jointly estimates the parameters of the selection and the marketing equation. Reported standard errors are based on the Huber-White estimator of variance. These standard errors are robust against many types of mis-specification of the model. Covariance between the probability of participation and the quantity traded (the ρ's) are captured by modelling the joint likelihood of market participation and traded values. The price variables used as regressors are the village mean unit values of maize and groundnut, the most important food and cash crop, respectively. These unit values are defined as purchased value divided by the amount purchased. The village means are formed after deflating the observations to account for seasonal price swings and removing the top and bottom 2.5% of the distribution (to reduce the impact of outliers). If no village observation is available, the mean for a higher administrative unit (the *Posto Administrativo*) is used instead. Consumer values are used because consumption data are much more frequent than sales data and because a careful previous adjustment exercise (documented in Ministry of Planning and Finance et al., 1998) has created consumption value and quantity data that are clean and take account of non-standard measurement units.

4. Results

4.1 Descriptive statistics

Table 1 shows descriptive statistics regarding market participation of the survey households for different crop categories, including the proportions of rural and urban households that sell crop output, disaggregated into basic food, cash crops, horticultural crops and fruits as well as the mean sales value in Meticais (where the mean is formed over the sellers only). It is evident that rural households are more likely to be sellers than urban households, and that the average value of their sales is higher. The only exception is horticultural crops, where peri-urban agriculture in "green zones" around the towns is important and over the years has received substantial government and donor support.

[Table 1 about here]

The livelihood of the vast majority of Mozambicans is based around the *machamba* (farm plot). Yet, while 94% of rural households operate some land (the mean is 2.4 ha per household), only 29% sell any crop output (see Table 1).[3] The most important commercial crops are basic food crops (such as maize, beans, cassava and rice) followed by cash crops (mainly groundnut and cotton). In contrast, fruit crops (cashew, mango and banana) are sold by many but in small quantities and was not a major cash earner at the time of the survey. Horticultural crops were not frequently sold. In rural areas, the average annual value of sales is 447,000 Meticais (Mt) per selling household, corresponding to 40 US$ at the time of the survey. This is a very low amount by any standard, and helps motivate the focus in this paper on peasant market integration. A farm survey, known as TIA, carried out roughly at the same time, did find larger market participation rates and average sales values (Heltberg 2001), so it is possible that the figures in Table 1 underestimate the true picture somewhat. On the other hand, in the IAF survey careful attention was paid to sampling, and it is not clear if TIA did the same.

4.2 Regression results

In Table 2, the regression results for market participation and sales value are shown for the rural sample of IAF.[4] There are three regression models, i.e., for (i) the log of total sales, (ii) the log of food crop sales, and (iii) the log of cash crop sales. For each model, results are reported in two columns. First, the column labelled quantity models the log of the annual value of sales given market participation. Second, the selection column shows the results of the marketing probability model.

The price of maize, a critically important food crop, does not appear to have any significant effects. The mean price of groundnuts - the most important cash crop - has a positive and significant effect on the quantity of total sales, while other parameters for groundnut price are not significant. As already mentioned, it is well-established that price responsiveness is hard to identify accurately in cross-sectional data. Thus, too much emphasis should not be put on these results.

Turning to the endowments of land and capital, three variables are included to characterize them: Farm size measured as land per household worker (aged 14-60), log number of trees (important for producers of cashew and other fruit crops) and a dummy for ownership of traction equipment. These variables are all positive and significant in several of the equations. Farm size, for example, is positive and significant for total output sales (both market participation and sales), as well as for food and cash crop market participation individually. Number of trees has significant positive effects on total sales (both equations) and on food crop market participation. The dummy for traction ownership is positive and significant only for total sales value. This shows that it is primarily those farmers who are relatively well-endowed with agricultural capital and land, who commercialize.

Household background characteristics are captured by dependency ratio (the number of dependants below 14 and above 60 per household member of working age), log age of the household head and by a dummy for households in which any member has paid employment. Age of head indicates the position of the household in the life cycle, while the dummy for paid employment is included to control for exogenous income earning opportunities (off-farm employment is relatively rare in Mozambique, is distributed in an uneven manner and access to it depends strongly on education and place of residence). Dependency ratio is not significant anywhere. Age of head is found to impact negatively and in a significant manner on the probability of market participation in all three models, but not on quantity sold. This finding may be explained by variation in cash need, variation in farming ability across the life cycle, or both. Paid employment has significant negative effects on market participation for both total output and cash crops. This may be due to different livelihood strategies for households depending on their access to employment - those without a job find it more pertinent to sell some output in order to meet cash needs.

Geographical and risk factors are captured by three sets of variables. First, the log of the mean yield of maize in the province of residence is included to capture the combined effect of technology, climate and past investment. Notice that we do not use the yield of the individual farm, which is unsuitable for inclusion in a regression such as this.[5] Second, a dummy for risky areas, defined as districts prone to drought, flood or both, is included to help take account of production risk at the local level. Third, we also include dummies for the country's major agro-ecological regions to control for the large spatial variation in cropping systems and relative prices. Dummies are included for the Northern and for the Central region, with South as the omitted category. Further details are available in Tarp, Simler, Matusse, Heltberg and Dava (forthcoming). They argue that regional differences should be taken into account to provide a true picture of poverty. We argue that the same goes for marketing decisions.

Maize yield has positive and significant impacts on market participation for both cash crops, food crops and all output as well as on total sales value. The dummy for risky areas has negative and significant impacts on market participation in all three models as well as on the value of total sales. Hence, improved food crop productivity and commercialization (of all crops) go hand-in-hand. The relationship goes both ways. Better food crop productivity frees up labour and land resources for market production. Also, there are spillovers from cash crops onto other crops through redirection of inputs and management techniques. Living in a risky region is clearly associated with less commercialization. The reason is probably the need to self-insure against climatic risk. In environments where insurance and credit markets are virtually absent, farmer risk aversion leads as already discussed to adoption of safe, low-yielding technologies in order to reduce ex-ante production risk. The dummies for the northern and central provinces take on mostly negative signs, four of which are significant, indicating the lower degree of market integration in these areas as compared to the South.

Variable transaction costs are captured by a dummy for ownership of transport (bicycle, motorcycle or car), by the log distance to a railway station and by the log distance to the provincial capital. These variables help proxy different aspects of transport costs, and since the relevant transaction cost/distance measure varies across households, each of the included variables will matter to some of the households but not to others. Transport ownership is positively and significantly related to sales value and market participation for all output combined and on cash crop market participation. Causality may run in both directions since crop sales help motivate and finance the purchase of, say, a bicycle. As regards the importance of transport ownership, our finding is in line with the observed tendency to rapid spread of bicycles in rural areas of Mozambique in recent years.

Distance to railway has the expected negative and significant effects on total sales (both value and participation) and on food market participation. Distance to the provincial capital has significant positive effects on market participation in all three models and for total sales value. This is counter-intuitive. Since provincial capitals tend to be important market centres, transaction cost considerations would make one expect market participation to decrease, not increase, with distance. However, off-farm employment opportunities are much better close to the provincial capitals. To the extent that off-farm employment and reliance on output sales markets are substitutes, and the included dummy for those *currently* holding a job does not adequately capture job *availability* (say, for seasonal workers), the labour market effects of living close to a town can explain the sign of this variable.

Fixed transaction costs (the τ variables), can be measured by variables that describe household access to and ability to process market information. Recall that fixed transaction costs have a lump sum nature so they are not supposed to affect each individual transaction but rather the probability of participating in markets. Fixed transaction costs are captured in our data by a dummy for ownership of radio, telephone or TV (for access to information), by the maximum education level of the household head (for the ability to process information) and by the district population density (a proxy for the density of information and marketing networks). Ownership of radio, TV or telephone is significant and positively related to food crop market participation (causality, however, could be in either direction). Education of the household head and district population density are not significant. Thus, the proxies included here to help capture fixed transaction costs yield mixed results and are not entirely convincing. The selectivity parameter, ρ, is significant in the regressions for all crops combined and for cash crops, but not in the regression for food crops, reinforcing the suspicion that in this case identification of the selection equation might be improved. To do so in this kind of models, better proxies or even direct measurements of fixed transaction costs would be required. In sum, results regarding fixed transaction costs should be interpreted with caution.

[Table 2 around here]

4.3 Market participation and poverty

Non-parametric or kernel density regression techniques can be used to explore how market participation depends on the income level of the household (Deaton, 1997). We do this by recovering from the regressions in Table 2 the estimated marketing probabilities. The conditional distribution of these marketing probabilities is plotted against household per capita expenditure using a standard Epanechnikov kernel and a bandwidth (the degree of smoothing) of 0.6-0.8. Figure 1 shows that the overall marketing participation increases with expenditure. Cash crops show the largest difference in marketing probability for the upper quintiles relative to the lowest (Figure 3). From Figure 2 it appears that the gap in the probability of marketing food between the upper and the lower end of the rural income distribution is less pronounced than it is for cash crops (the apparent drop over part of the range in marketing probability should not be over-emphasized). One can hypothesize that since food crops are grown by almost everybody, selling a bit of maize from the granary is a cash earning strategy that is broadly available. Cash crop marketing, on the other hand, requires a prior decision to move out of subsistence, and is cleary more concentrated in the upper end of the income distribution. It should be kept in mind that we are considering quite modest variation since almost all the rural households in this sample are small, poor peasants by international standards. We conclude from this that poverty oriented commercialisation policies should not overlook improved market integration of basic food crops.

4.4 Marginal effects of the poor and the nonpoor

In the following, we investigate to what extent the potential for enhanced commercialization and supply response differs between poor and nonpoor smallholders so as to better understand the factors underlying the observed differences in market integration across the income range. Conceptually, there are two ways in which supply response can depend on welfare level or poverty status. One, the assets, technologies and incentives available to the poor and the nonpoor may differ. This is for example the case when the poor are excluded from market participation for lack of labour or land. Or, two, the behavioural responses (controlling for assets, technologies and incentives) may vary between the poor and the nonpoor. This is for example the case when risk aversion or lack of entrepreneurial talent or knowledge confine the poor to a subsistence orientation.

In the following, we investigate these possibilities by splitting the sample into a poor and a nonpoor sub-sample and running the Heckman regression (for total sales) separately for each. The separation of the sample into groups of poor and nonpoor households is based on a national poverty line, determined according to a Cost of Basic Needs method, and documented in Tarp *et al.* (forthcoming) and in Ministry of Planning and Finance et al. (1998). National headcount poverty is 69 per cent and in rural areas it is 71 per cent.

The regression results are reported in Table 3. There are several quantitative differences in the estimated parameters for the poor and the nonpoor, and indeed a Chow test strongly rejects the hypothesis that the two regressions are identical (see bottom of Table 3). Yet in qualitative terms the determinants of commercialisation do not appear substantially different between the poor and the nonpoor. In order to better facilitate comparison, marginal effects for each sub-sample are derived and used to investigate if the poor exhibit different behavioural responses than the nonpoor.

Before discussing these results, it will be useful to clarify the concept of marginal effect, or elasticity of supply within the context of the Heckman or switching regression model. Marginal effects show the change in supply that would be induced by a marginal change in the exogenous variables. They summarize the information embedded in the selection and value parameters, including cases where these have opposite signs, allowing the researcher to quantify the impact of different explanatory variables. For selection models, a number of different marginal effects can be derived which differ in interpretation, causing some confusion in the literature (McDonald and Moffitt, 1980). Marginal effects depend on regime selection and the appropriate choice hereof depends on the particular interpretation of interest. These marginal effects are: *(i)* the marginal change in the probability of participating in the market as derived from the selection equation; *(ii)* the change in desired marketed quantities (for the full sample) that can be derived directly from the estimated parameters in the quantity equation; *(iii)* the conditional marginal effects (i.e., given market participation), using information only for those already in the market; and *(iv)* the unconditional marginal effects. The unconditional elasticities of supply and demand are derived for the entire sample (as opposed to only those at the market), and they show the impact of parameters on observed (as opposed to 'desired') quantities. As unconditional effects refer to the expected change in actual quantities traded on markets they are of key policy interest and are in focus in this paper.

Huang, Raunika and Misra (1991) show that for any variable x in the X vector, the unconditional marginal effect can be derived as

$$\begin{aligned} ME^{x} &= \frac{\partial s}{\partial x} = \beta^{x}\Phi(\gamma X + \kappa\tau) + \gamma^{x}\phi(\gamma X + \kappa\tau)[X\beta + (\gamma X + \kappa\tau)\rho] \\ &= \beta^{x} \cdot psel + \gamma^{x} \cdot \phi(xbsel) \cdot ycond \end{aligned} \tag{6}$$

where $\Phi(\cdot)$ and $\phi(\cdot)$ denote the standard normal distribution and density functions, respectively and β^{x} and γ^{x} are the estimated parameters for variable x in the quantity and selection part of the model, respectively. The first part of expression (6) represents the change in quantity in response to a change in x (β^{x}) weighted by the probability of being in the market (*psel* in *Stata* language); and the second part represents the change in the probability of being on the market (γ^{x} ϕ*(xbsel))* weighted by the expected value traded if on the market (*ycond* in *Stata* terminology). In this paper all marginal effects are evaluated at the mean of the data. Note that since the τ variables do not appear in the quantity part of the model, only part 2 of equation (6) can be calculated.

The unconditional marginal effects associated with the regression results for total sales are shown in Figure 4 for the poor and the nonpoor sub-samples.[6] The largest effects on commercialization come from the following variables in descending order of importance (and with sign of impact in parenthesis): yield of maize (+), risky area dummy (-), dummy for off-farm employment (-), ownership of transport equipment (+) and distance to provincial capital (+), with other variables further down the list. This suggests that the quantitatively most important factors for commercialization are those that relate to the area such as risk and yield as well as to key household characteristics such as job status and transport ownership.

By comparing the total MEs for the poor and the nonpoor, it can be seen that the marginal effects of the nonpoor are larger in absolute terms than those of the poor, but the difference is not substantial. This suggests that the underlying behavioural relationships of these two groups of poor and nonpoor households may not be very different. Given the Mozambican context of modest rural inequality, this finding is not surprising: only few farms in the survey have made the transition from smallholder to capitalist production.

Observed differences seem to a substantial extent to be caused by area-based differences between the areas in which the poor and the nonpoor typically live. When looking at the means of the exogenous variables across poverty groups (not shown), it is interesting that the mean for maize yields is higher while the mean of the risk dummy is lower for the nonpoor. Because these two variables have large marginal effects, area-based differences between the poor and the nonpoor appear to account for an important share of the variation in commercialization. The policy implication is that support for smallholder asset building and improvements in technology and in market access targeted to the poor are likely to pay off.

Another interesting decomposition of the marginal effects consists of breaking them down into a quantity component (part 1 of equation (6)) stemming from the response of farmers already on the market and a participation component (part 2 of the equation) stemming from those who would enter/exit the market in response to changes in the exogenous variables. Part 1 and part 2 are directly comparable in magnitude. This decomposition, shown in Figure 5 for the full sample, brings out an interesting implication of the regression results. Part 2 of the marginal effects (i.e., the weighted entry/exit component) is substantially larger than part 1 (i.e., the quantity component) for almost all regressors. The implication is that interventions to promote market access are likely to solicit a greater volume of additional supply from peasants entering the market for the first time than from existing market participants stepping up their production and sales.

5. Conclusions

In this paper, we have applied the Heckman or switching regression framework to help assess what determines the likelihood and the extent of smallholder market participation within the Mozambican context of widespread poverty and subsistence production. Improved agricultural technology, access to markets, better risk management and expansion of basic physical capital appear crucial for agricultural market expansion. Risky and low-yielding environments, lack of basic farm assets and high transaction costs present large obstacles for integration of smallholders into the market economy. Substantial supply response can be solicited if barriers for market access can be overcome. Agricultural development programmes should invest in key non-price factors such as improved technology, transport infrastructure and farm capital, and strive to help farmers better deal with risk.

No big difference was found in the manner in which poor and nonpoor smallholders respond to incentives, as suggested by the fact that the estimated marginal effects for the two groups are quite similar. Yet, the poor in Mozambique are more likely to live in high-risk and low-yield areas, and own less basic farm capital goods. To achieve pro-poor rural growth, addressing these factors and increasing the productivity and market integration of basic food crops is essential.

Endnotes

1. While it is argued here that commercialization is crucial for development, we agree with von Braun and Kennedy (1994, p. 366) that there may be backlashes resulting from past and present policy failures, and certain groups may be disadvantaged. It is essential that the poor are not adversely affected by commercialization policies.

2. See Streeten (1987) for a general survey, whereas Tarp (1990) reviews agricultural price policy in Mozambique.

3. All descriptive analyses in this paper apply the population sampling weights (called expansion factor) that resulted from the sampling stratification procedure of IAF. Regressions are unweighted.

4. Since data on most village-level characteristics and transaction cost determinants are unavailable for urban areas, the regression analyses in this paper are confined to rural households.

5. Individual farm yield is unsuitable for inclusion because it is endogenous and depends on farm size and other factors (Heltberg, 1998).

6. As these marginal effects are estimated from cross-section data, they are essentially short-run in nature. Since agriculture may respond with considerable lags, long-run supply elasticities will be more elastic with respect to prices and other factors than in the short run (Binswanger, 1990).

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Table 1: Participation in food markets

	Rural		Urban	
	% sellers	Mean sales value (MT)	% sellers	Mean sales value (MT)
Basic food	14.3%	187,958	2.5%	178,226
Cash crops	7.1%	520,031	0.9%	84,185
Horticultural crops	1.5%	165,783	1.0%	232,308
Fruit crops	11.5%	70,992	3.3%	13,757
All output	29.2%	446,785	6.1%	233,538

Households are weighted by sampling weights.

Table 2: Regression results (Heckman model)

	Sales of					
	All crops		Food crops		Cash crops	
	Quantity	Selection	Quantity	Selection	Quantity	Selection
Log maize price	-0.071	0.031	-0.161	-0.203	-0.314	-0.157
	(0.32)	(0.28)	(0.59)	(1.68)	(0.42)	(0.79)
Log groundnut price	0.361	0.057	0.069	0.016	-0.267	0.175
	(2.62)**	(0.76)	(0.58)	(0.18)	(0.69)	(1.80)
Farm size per household worker	0.133	0.099	-0.013	0.104	-0.113	0.135
	(2.75)**	(4.15)**	(0.10)	(3.32)**	(0.78)	(3.49)**
Dependency ratio	-0.023	0.087	-0.216	0.09	0.564	-0.13
	(0.11)	(1.00)	(0.82)	(0.89)	(1.15)	(1.06)
Log number of trees	0.268	0.368	-0.108	0.084	-0.177	0.043
	(3.08)**	(15.10)**	(0.93)	(4.07)**	(1.71)	(1.41)
Traction ownership dummy	0.500	0.111	0.421	0.214	-0.422	0.102
	(2.22)*	(1.06)	(1.17)	(1.75)	(0.65)	(0.48)
Log age of household head	-0.102	-0.151	0.31	-0.186	0.66	-0.254
	(0.76)	(2.16)*	(1.00)	(2.41)*	(1.75)	(2.83)**
Any member has paid job	-0.061	-0.268	0.38	-0.114	0.574	-0.434
	(0.39)	(3.51)**	(1.57)	(1.30)	(0.85)	(2.99)**
Log of mean maize yield in Province	0.674	0.814	-0.005	0.679	-1.632	0.81
	(2.00)*	(4.46)**	(0.01)	(2.87)**	(2.12)*	(3.19)**
Dummy for risky area	-0.901	-0.774	0.272	-0.805	-0.023	-0.627
	(2.97)**	(4.30)**	(0.29)	(3.23)**	(0.03)	(2.59)**
Northern region dummy	-0.176	-0.548	-0.16	-0.947	-1.492	-0.074
	(0.29)	(1.72)	(0.14)	(2.40)*	(1.03)	(0.16)
Central region dummy	-0.743	-0.337	-0.838	-0.391	-0.625	-0.884
	(1.57)	(1.40)	(1.45)	(1.36)	(0.50)	(2.42)*
Transport ownership dummy	0.356	0.235	0.151	0.121	-0.266	0.348
	(2.37)*	(3.14)**	(0.63)	(1.57)	(0.56)	(3.40)**
log Distance to railway	-0.138	-0.109	0.047	-0.119	-0.293	-0.052
	(2.25)*	(3.15)**	(0.29)	(3.31)**	(1.67)	(0.92)
log Distance to Province capital	0.268	0.205	-0.154	0.377	0.03	0.241
	(2.19)*	(2.80)**	(0.30)	(3.65)**	(0.09)	(2.40)*
Own radio, TV or telephone?		0.013		0.133		0.075
		(0.24)		(2.30)*		(1.35)
Maximum education of household head		0.105		0.034		-0.008
		(1.60)		(0.47)		(0.10)
District population density		-0.001		-0.001		0.002
		(0.41)		(0.39)		(0.97)
Constant	8.717	-0.568	13.604	0.872	20.406	-0.9
	(3.51)**	(0.48)	(5.44)**	(0.64)	(3.25)**	(0.46)
ρ (selectivity parameter)		0.439		-0.681		-0.940
χ^2-test for independent equations (ρ=0)		5.88		0.52		17.01
P-value		0.015		0.471		0.000
Observations	5385	5385	5385	5385	5385	5385

Robust z-statistics in parentheses. * significant at 5% level; ** significant at 1% level

Table 3: Regression results for poor and nonpoor (Heckman model)

	Sales of all crops			
	poor subsample		nonpoor subsample	
	Quantity	Selection	Quantity	Selection
Log maize price	-0.331	-0.055	0.322	0.177
	(1.40)	(0.44)	(1.26)	(1.23)
Log groundnut price	0.339	0.102	0.438	-0.019
	(2.19)*	(1.28)	(3.42)**	(0.20)
Farm size per household worker	0.069	0.079	0.184	0.116
	(1.36)	(2.96)**	(2.63)**	(3.31)**
Dependency ratio	0.243	0.199	-0.012	0.126
	(0.87)	(1.52)	(0.04)	(0.90)
Log number of trees	0.314	0.37	0.129	0.368
	(2.83)**	(12.79)**	(0.77)	(12.21)**
Traction ownership dummy	0.194	0.114	0.719	0.061
	(0.73)	(0.83)	(2.31)*	(0.50)
Log age of household head	0.019	-0.093	-0.061	-0.242
	(0.11)	(1.11)	(0.27)	(2.18)*
Any member has paid job	-0.103	-0.266	-0.041	-0.27
	(0.56)	(3.22)**	(0.15)	(2.38)*
Log of mean maize yield in Province	0.746	0.773	0.519	0.864
	(2.06)*	(3.99)**	(0.88)	(3.46)**
Dummy for risky area	-0.945	-0.742	-0.616	-0.842
	(2.63)**	(3.90)**	(1.12)	(3.48)**
Northern region dummy	-0.349	-0.38	0.241	-0.901
	(0.53)	(1.19)	(0.28)	(2.07)*
Central region dummy	-0.935	-0.217	-0.309	-0.548
	(1.96)*	(0.89)	(0.51)	(1.66)
Transport ownership dummy	0.222	0.229	0.492	0.221
	(1.30)	(2.89)**	(2.15)*	(1.92)
log Distance to railway	-0.127	-0.102	-0.143	-0.122
	(1.77)	(2.75)**	(1.43)	(2.88)**
log Distance to Province capital	0.222	0.158	0.259	0.285
	(1.74)	(2.14)*	(1.43)	(2.83)**
Own radio, TV or telephone?		0.053		-0.039
		(0.80)		(0.44)
Maximum education of household head		0.025		0.128
		(0.18)		(1.73)
District population density		-0.002		0.002
		(1.29)		(0.65)
Constant	10.716	-0.453	4.833	-0.855
	(3.90)**	(0.35)	(1.79)	(0.53)
ρ (selectivity parameter)		0.474		0.250
χ2-test for independent equations (ρ=0)		4.32		0.30
P-value		0.038		0.584
Chow test: equations for poor and nonpoor are the same			$\chi^2(38)=77.6$;	prob=0.0002
Observations	3488	3488	1897	1897

Robust z-statistics in parentheses. * significant at 5% level; ** significant at 1% level

Figure 1. Nonparametric regression of total sales probability

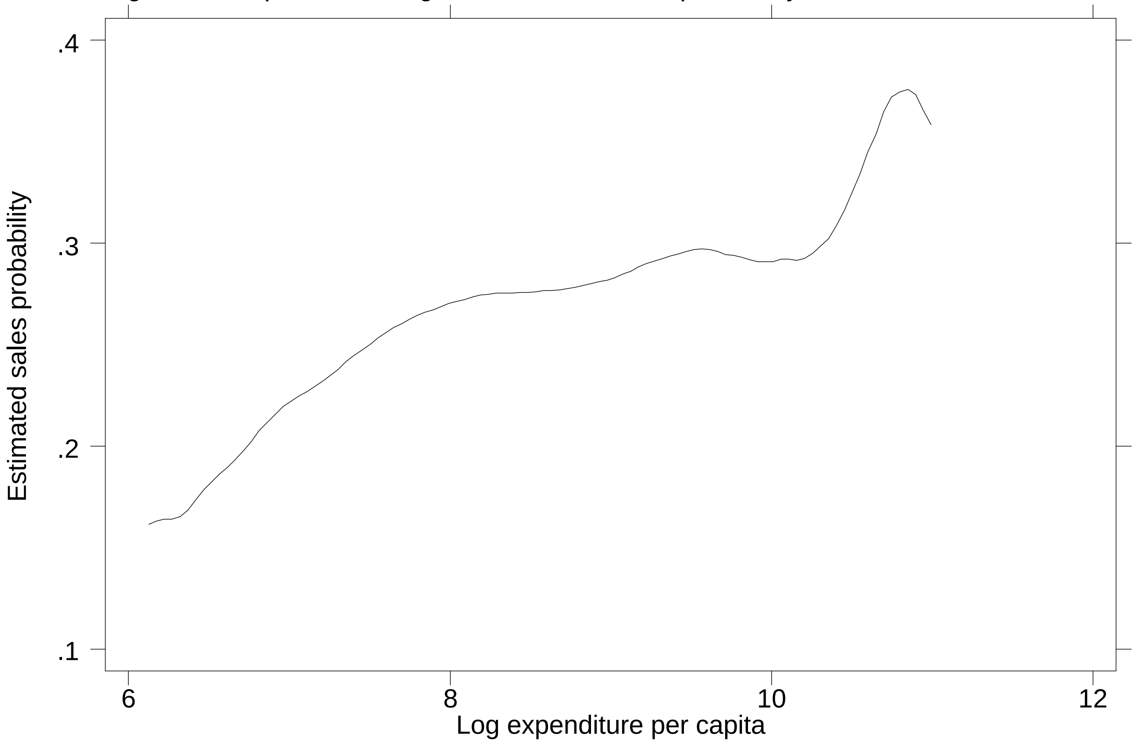


Figure 2. Nonparametric regression of food sales probability

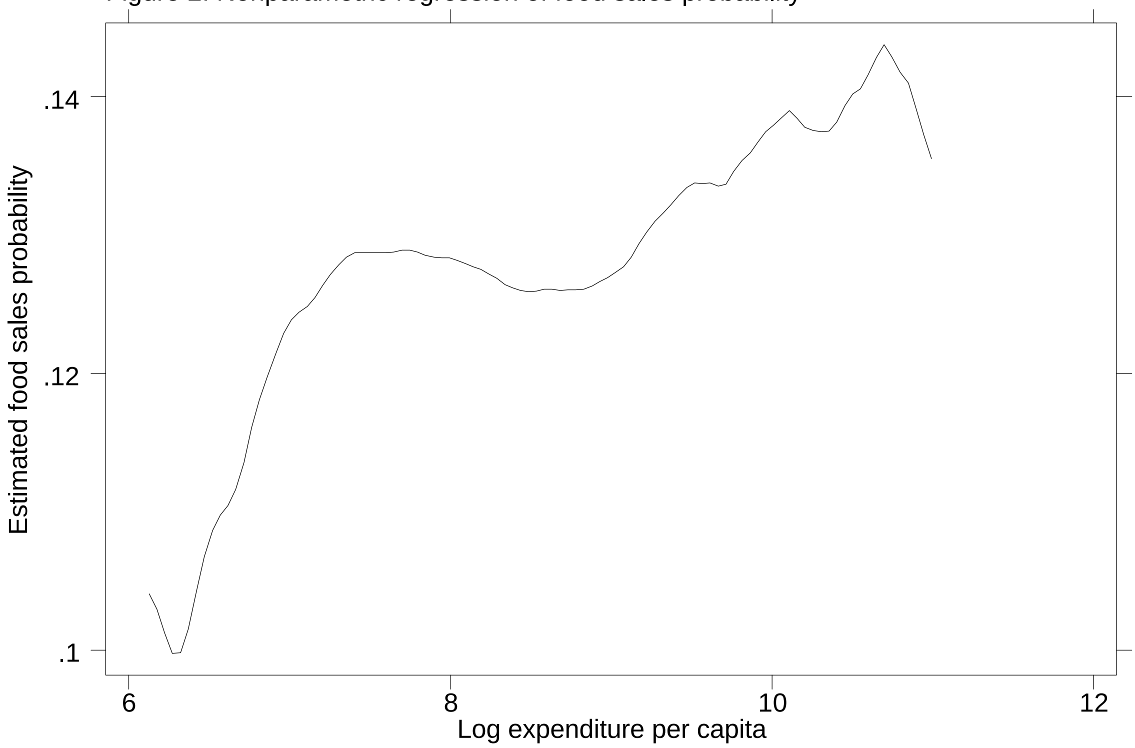


Figure 3: Nonparametric regression of cash crop sales probability

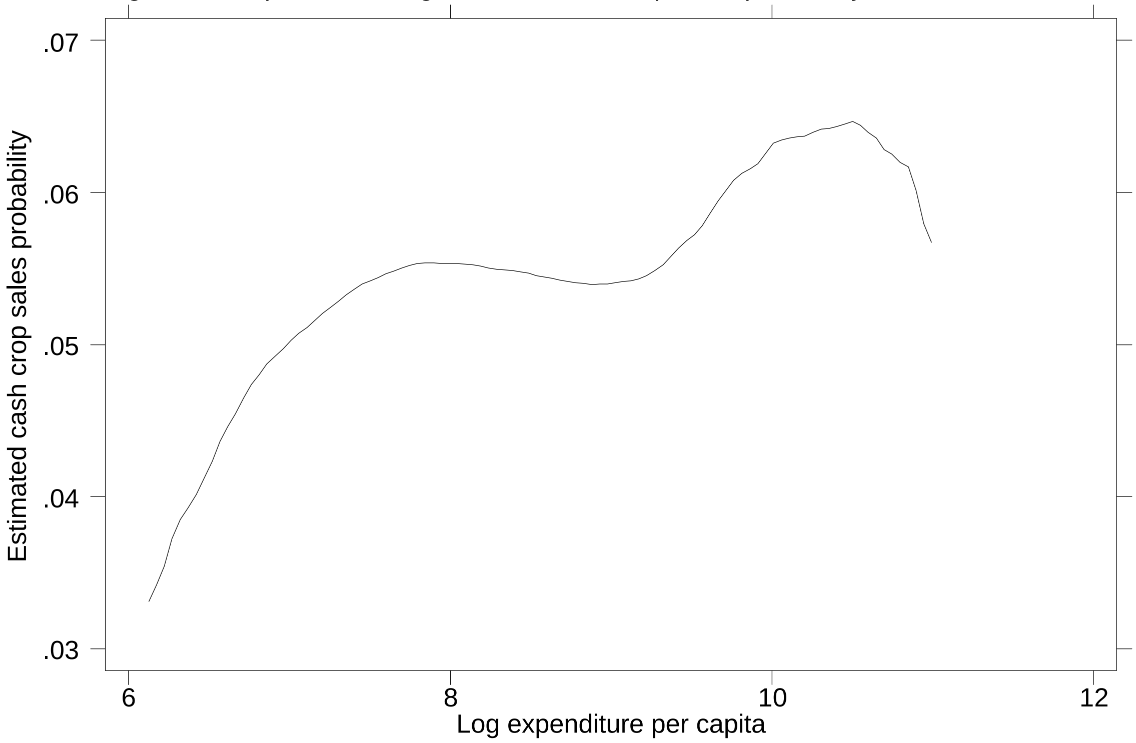
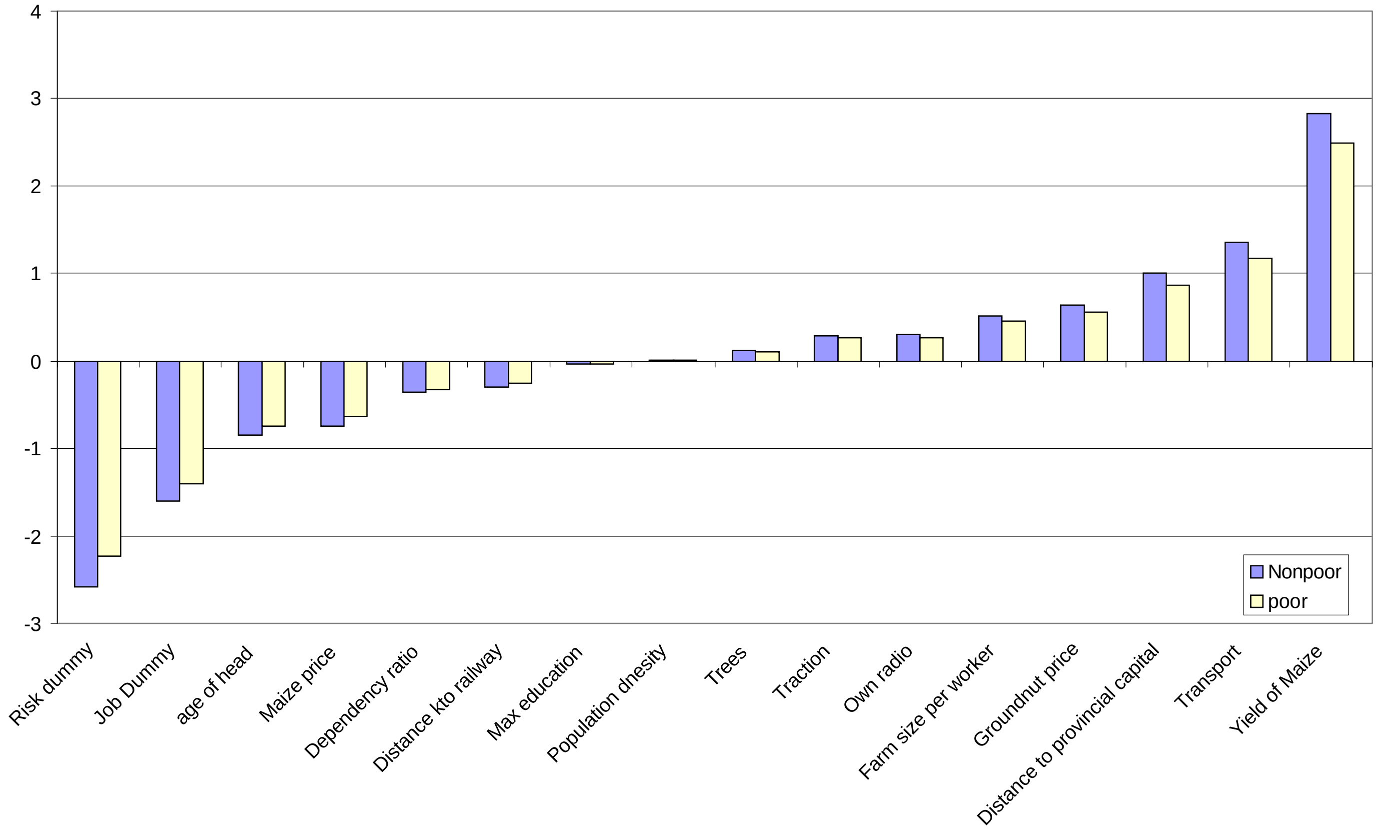


Figure 4: Marginal effects for poor and nonpoor (total sales value)



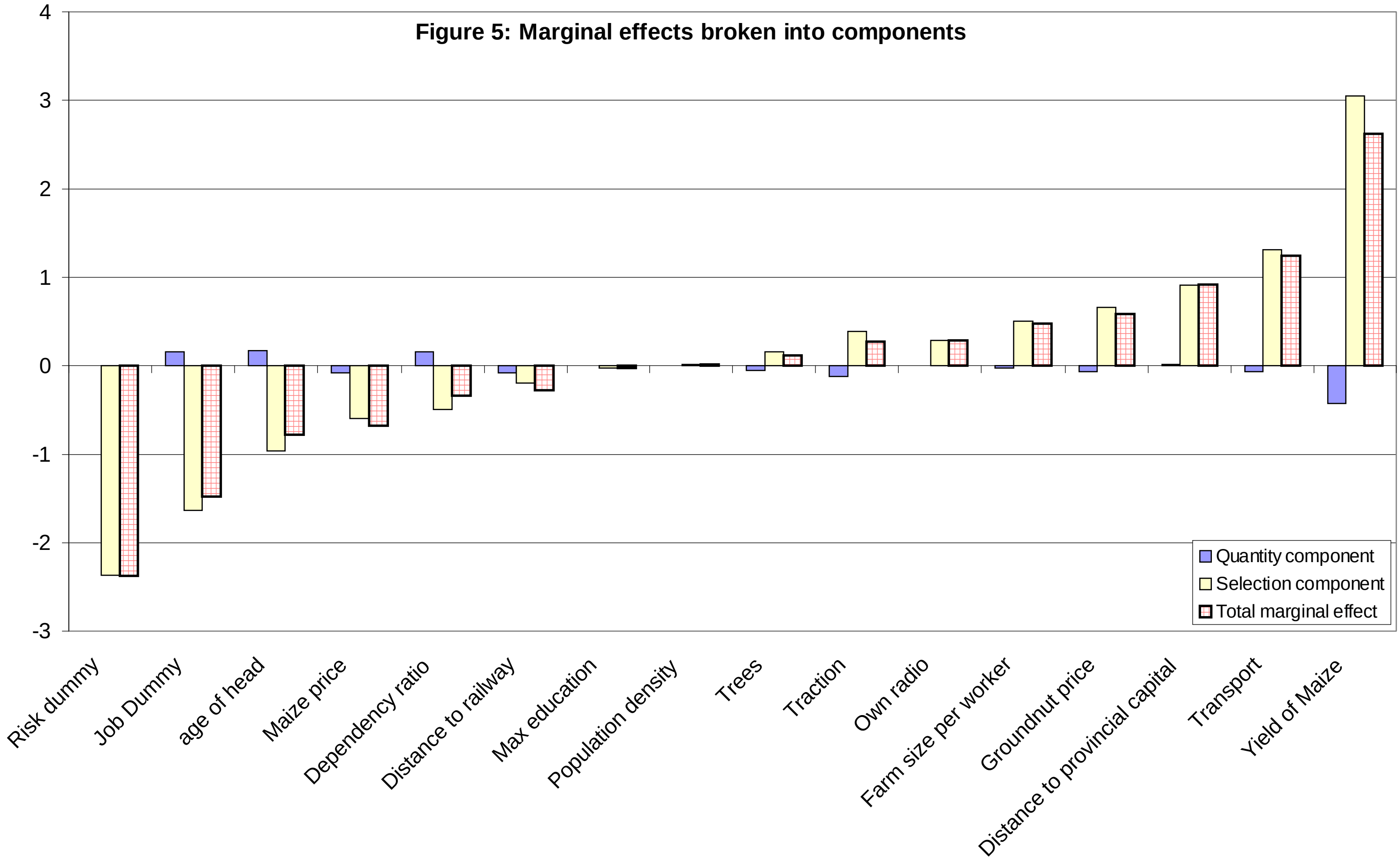


Figure 5: Marginal effects broken into components